SPH4U: Energy and Momentum Review

$\vec{p} = m\vec{v}$	$\Delta\vec{p} = \vec{F}\Delta t = m\Delta\vec{v}$	$W = F\Delta d\cos\theta$	$F = \lvert kx \rvert$
$E_k = \frac{1}{2}mv^2$	$E_e = \frac{1}{2}kx^2$	$E_g = mgh$	$W = \Delta E_k$
$R_{earth} = 6.38 \times 10^6$ m	$M_{earth} = 5.98\text{x}10^{24}$ kg	$G = 6.67\text{x}10^{-11}$ Nm^2/kg^2	$E_g = -\frac{GMm}{r}$

1. How much work needs to be done to lift a 5.0 x 10^2 kg satellite from the surface of the Earth to a height of 200 km above the surface? How fast does the satellite need to be launched from the earth so that it reaches this height before falling back to earth?

2. A 19 kg curling stone is sliding along the ice at 4.6 m/s [E 10° S] when an errant hockey puck (170 g) traveling at 20 m/s [N 55° E] strikes it. After the collision, the curling stone continues on at 4.61 m/s [E 6.56° S]. Determine the velocity of the hockey puck immediately after the collision.

3. You apply a horizontal force of 500 N to push around a shopping cart at a constant speed of 1.5 m/s for an hour. (a) How much work have you done? (b) How much work was done on the shopping cart?

4. In yet another mishap in his misguided mission to make a meal of the Roadrunner, Wile E. Coyote (50 kg) flies horizontally through the air towards a brick wall. A conveniently placed spring (k = 5000 N/m) compresses 0.75 m and brings him to a complete stop in 0.45 s. (a) What is the maximum force exerted by the spring on the coyote? (b) Assuming that the force exerted by the spring increases linearly with time, sketch a graph of the spring force as a function of time from first contact until the coyote comes to a stop. (c) Using your graph, find the coyote's change in momentum. (d) What was the coyote's speed when he first came in contact with the spring?

5. A certain amphibian (25 kg) jumps vertically up off a platform 3.5 m high with an initial speed of 2.0 m/s, but fortunately lands on (sticks to) a 50 kg giant marshmallow just above the ground. The marshmallow is attached to a spring, which compresses 20 cm before the amphibian is brought to a stop.

Using energy and momentum techniques only, determine (a) the speed of the amphibian just before contact with the marshmallow, (b) the speed of the amphibian and marshmallow immediately after impact, and (c) the spring constant (in N/m). Don't forget that there is also a change in gravitational potential energy when the spring compresses!

1. 9.5×10^8 J, 1.9×10^3 m/s 2. 22 m/s [E 60° S] 3. 2.7×10^6 J, 0 J 4. 3750 N, -8.4×10^2 kg m/s, 1.7×10^1 m/s 5. 8.5 m/s, 2.8 m/s, 2.2×10^4 N/m